NSF Nugget
Polymers Program
Division of Materials Research
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Andrew Lovinger, Program Officer

Introduction

The broader impact of this research is the development of enhanced dissolution processes of industrial polymers and our NSF sponsored research has developed an analytical method (Spectroscopic imaging using Fourier Transform Infrared Spectroscopy) of measuring the type and rate of dissolution of polymers under a variety of environmental conditions and solvent conditions.

Probing the Mechanism of Controlled Drug Release

As a result of a presentation by a student, one of the pharmaceutical faculty inquired about using our approach for studying the mechanism of controlled drug release. In response to this inquiry, we studied the release of testosterone from PEO tablets. The response of a binary solid solution of drug and polymer to water mimics a common scenario of oral drug delivery was investigated.

Experimental results

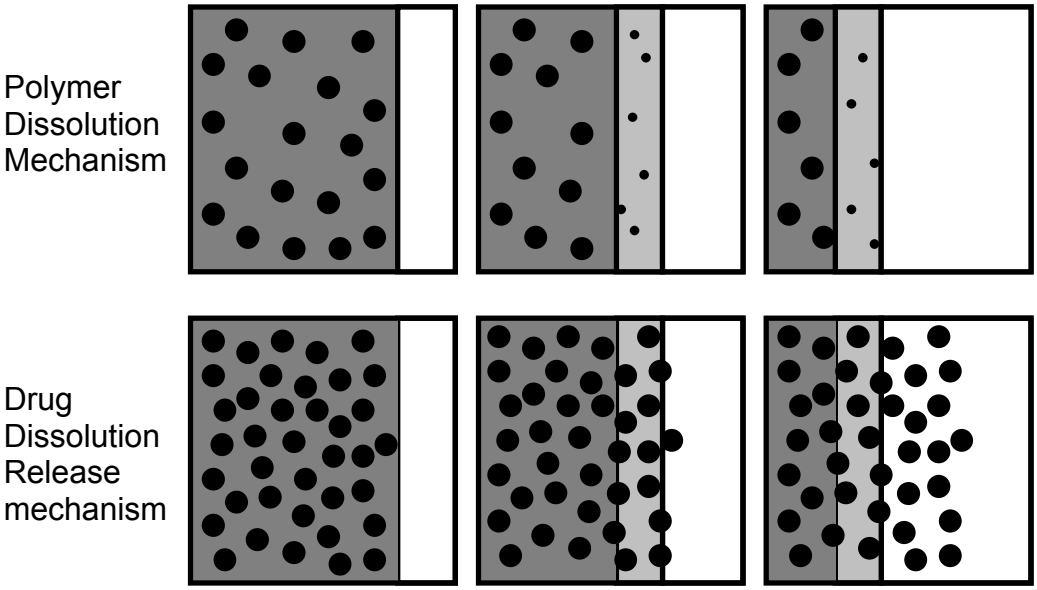
The dissolution of the polymer matrix was characterized by a sharp boundary at the bulk polymer solvent interface, as evidenced by the sustained sharpness of the polymer absorbance profiles and explained by the crystalline character of the polymer. Velocity profiles showed the polymer dissolution was not constant with time, yet the size of the gel layer remained constant. The calculated diffusion parameter indicated anomalous behavior for the dissolution of the neat polymer and Fickian behavior for the dissolution of the polymer containing drug concentrations.

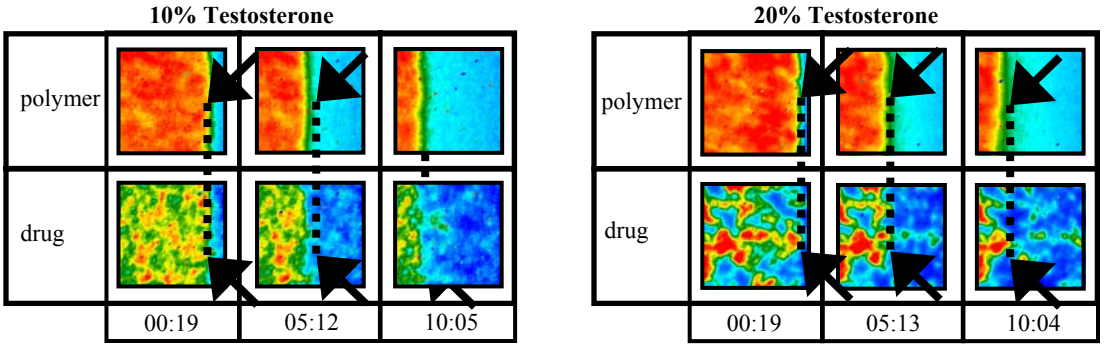
Interpretation of Drug Release Mechanism

A visual observation of the images as well as quantitative information extracted from the data cubes showed that two delivery mechanisms were observed. One release mechanism is determined by the dissolution rate of the polymer. This mechanism was observed for low drug loadings of 10 and 20%. The second release mechanism was determined by the dissolution rate of the polymer. This mechanism was observed for high drug loadings of 30 to 40%.

Impact of Research on Controlled Drug Release

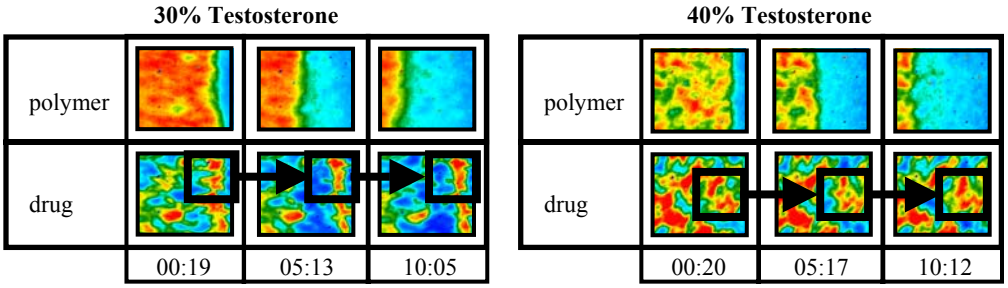
This work was published in the Journal of Controlled Release: [Carrie A. Coutts-Lendon, Norman A. Wright, Ellen V. Mieso and Jack L. Koenig, J of Controlled Release,93, 223-248, (2003) **"**The use of FT-IR imaging as an analytical tool for the characterization of drug delivery systems" and was awarded the 2003 Jorge Heller Outstanding Paper Award from the Controlled Release Society).





(a) (b)

Images of the polymer and drug extracted from the beginning, middle and end of the release process. The sustained alignment of the polymer and drug dissolution fronts relative to one another indicates the polymer is acting as the release mechanism.



(a) (b)

Images of the polymer and drug extracted from the beginning, middle and end of the release process. The portions of drug remaining in the solvated area throughout the process, highlighted by the boxed area, indicate the dissolution of the drug dictates the release rate of the drug.